16. RECOVERY OPERATIONS

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Summary

The basic philosophy for the recovery phase of Project Mercury was to provide a positive course of action for any conceivable landing situation that could develop, and to provide recovery support according to expected needs and the probability of such situations occurring. Throughout the program this philosophy was continuously reviewed as experience was gained and mission complexity increased. Although certain improvements and changes were made in recovery equipment and techniques, there was no significant change in the basic philosophy originally adopted and all recovery operations were highly successful.

Introduction

This paper presents a general review of the recovery planning and operations conducted for Project Mercury. A discussion of the overall recovery philosophy and a brief description of the location and retrieval techniques that were planned and used for spacecraft recovery are included.

Recovery Philosophy

In reviewing Project Mercury recovery operations, it is appropriate to go in some detail into the basic philosophy upon which recovery planning was based. The foundation of this philosophy was the premise that a positive course of action to provide safe recovery of the astronaut would be planned for all conceivable landing situations, including provisions for the most expeditious return of the spacecraft. The type of action to be taken was determined by the probability of occurrence and location of the landing. For this purpose, possible landings were divided into five general categories, as follows:

(1) The first category included landings which might occur during that period of the mission from arming of the launch escape system prior to launch until that point after launch where an abort would result in a landing within 12 miles of the launch site at Cape Canaveral. This area is referred to as the "Launch Site Abort Landing Area."

(2) Aborts subsequent to this time and prior to insertion of the spacecraft into orbit would result in a landing in one of several planned "Pre-orbital Abort Landing Areas."

(3) After the spacecraft was committed to orbit, Planned Landing Areas were selected so that a landing could be made in the vicinity of predeployed recovery forces at approximately 100-minute intervals through the flight.

(4) The "Primary Planned Landing Area" was that area where the flight would be ultimately terminated, if possible.

(5) Finally, a landing might occur at any place along the ground track as a result of an emergency situation. This emergency might not permit the spacecraft to reach one of the planned landing areas and, therefore, would result in a contingency recovery situation. A location capability was provided along the entire ground track of the flight. To reduce the search area, when some choice of spacecraft landing point remained available, so-called preferred contingency landing areas were designated. These areas were intermediate locations along the ground track between planned landing areas that either were adjacent to land areas or location forces.

The degree of support in terms of the number of ships, aircraft, and personnel planned for

each of these landing areas was determined by the degree of probability that a landing might occur. Hence, since the greatest probability of a landing was in the primary landing area, the greatest level of support was provided here. The amount of support provided for contingency landings was considerably less, consistent with the much lower probability of a contingency landing.

It can readily be seen that extensive recovery forces were necessary to support this philosophy. In keeping with the National Space Act, maximum utilization was made of Department of Defense (DOD) capabilities, with a minimum of interference with their normal operational functions. (See paper 9.) Although standard DOD ships and aircraft could be utilized, the requirement existed for specialized equipment to support the Project Mercury recovery operation. The special equipment necessary was provided by the NASA. Indoctrination and training programs were conducted to establish and qualify recovery procedures and familiarize the forces involved with the use of specialized equipment and techniques.

This basic philosophy for recovery planning was continuously reviewed throughout the program, particularly in light of experience gained from each successive mission and with regard for the increasing complexity of forthcoming missions. Nothing developed to justify any significant change in the basic philosophy originally adopted, although certain improvements and changes were made in the equipment and techniques used in support of the recovery plans.

There are three major phases in the recovery operation: location, retrieval, and postrecovery activities. The location phase began with the notification of the recovery forces that a landing was imminent and the general area in which the landing could be expected. As the landing progressed from retrofire through reentry to actual touchdown, information from the Mercury Worldwide Network provided a predicted landing point.

Search aircraft, both airborne and on station in the planned landing areas or staging from a contingency deployment site, then proceeded toward this point conducting an ultra-high frequency/direction finding (UHF/DF) electronic search for the spacecraft recovery beacon or personal survival beacon enroute. Upon receiving a signal, they would then home in on it until close enough to conduct a visual search, aided in daylight by dye expelled from the spacecraft or by a flashing light at night.

In the absence of a reliable network landing-point prediction, alternate sources could be called upon for such information. Some geographical areas were blanketed with either HF/DF or SOFAR networks which could determine the general location of spacecraft landing within their limits of coverage. For landings outside those areas, where no other specific location information was available, location would be accomplished by searching the ground tracks along which the landing could have occurred.

In the early part of the project it was desirable that the retrieval of the spacecraft could be accomplished by either ships or helicopters. All ships utilized in the program had the capability of lifting the spacecraft from the water. Those ships not having a lifting crane could, with a minimum of modifications, utilize their existing boat davits to lift the spacecraft (fig. 16–1). Helicopters with the capability of lifting the spacecraft were equipped with special hooks and lifting slings (fig. 16–2) to provide them with a man-rated retrieval system. Early in the project, when uncertainties about the condition of the spacecraft and occupants were the greatest, helicopters were considered the most desirable means of retrieval because of their ease of access to the scene of the landing and the rapid method of spacecraft retrieval.

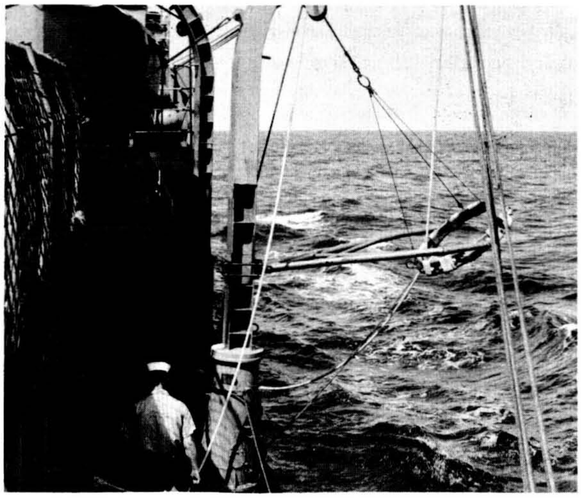


FIGURE 16–1.—Modified davit and hold-off rig on destroyer.

Figure 16–2.—Spacecraft being lifted from water by helicopter.

Procedures were established whereby the astronaut would be retrieved by the same helicopter that picked up the spacecraft. It was not possible to have helicopters in all the landing areas, however; so in those areas of lower landing probabilities only ships, with retrieval capability, were provided.

This philosophy existed throughout the early development flights at Wallops Island and through the Redstone program. The helicopter retrieval method by its very nature required maximum demands on both personnel and recovery equipment. The experience of MR–4, when the helicopter was able to hook the spacecraft but was unable to retrieve it successfully, pointed out the limitations of this method. It was apparent then that this method exposed itself to many hazards that were not desirable.

During the early development flights, a concurrent program for development of an auxiliary flotation collar was underway. The attachment of this collar (fig. 16–3) to the spacecraft

Figure 16–3.—Auxiliary flotation collar.

provided increased flotation capability to the spacecraft under all water-landing conditions. The collar also provided a suitable working platform for rendering assistance to the astronaut, and it also served as a platform from which the astronaut could be retrieved by helicopter. The spacecraft, even with an open hatch, was seaworthy when fitted with the auxiliary flotation collar.

After the suborbital flights had been completed, the following technique was instituted as the primary retrieval method. After spacecraft location, either swimmers or pararescuemen, deployed by helicopter or aircraft, would attach the flotation collar to the spacecraft. The astronaut could then exit the spacecraft or remain within as he chose. Medical assistance could be given and spacecraft systems could be secured as well. Retrieval of the spacecraft was to be made by surface ships and use of the helicopters was primarily intended for retrieval of the astronaut only.

Following retrieval, the post-recovery activities of the astronaut include: personal medical attention as required; physical examinations; a medical debriefing and technical debriefings with trained specialists in these fields; and scheduled rest periods. Following retrieval of the spacecraft, trained personnel secured the spacecraft systems, conducted initial postflight

inspections, and removed the onboard data for rapid delivery to Cape Canaveral. The spacecraft was then transported by special airlift to Cape Canaveral for detailed inspection and analysis.

The recovery plan for contingency area landings included the deployment of pararescue men by parachute as soon as possible after the spacecraft had been located by search aircraft. For water landings the auxiliary flotation collar, also dropped by parachute from the search plane, was then attached to the spacecraft so that the astronaut could emerge to await rescue. Rescue of the pilot and retrieval of the spacecraft were then to be accomplished by the most expeditious means available under the circumstances. Had the spacecraft been located by an aircraft not carrying pararescuemen, or had local conditions precluded their jumping to the spacecraft before the aircraft had to leave the landing area, drop buoys were provided to assure relocation of the spacecraft. These buoys were fitted with radio beacons compatible with the UHF/DF equipment in the search aircraft.

Many other preparations were made to insure a safe and rapid recovery. For example, a worldwide recovery communications network was established utilizing both DOD and commercial facilities. This extensive communication network was required to provide for rapid reporting and coordination among the recovery forces, Area Command Centers, and the Recovery Control Center at Cape Canaveral. A worldwide weather reporting and analysis system was also established to provide pertinent meteorological data in the recovery areas, so that action could be taken to delay the launch or move the recovery area in the event of adverse weather conditions.

Table 16–I provides pertinent recovery facts for all Project Mercury missions and shows how the various preparations described above were useful in each case.

Table 16–I.—Summary of Recovery Operations for Project Mercury

Flight	Launch date	Description	Range, nautical miles	Recovery forces		Location method	Retrieval by	Remarks
				Ships	Airplanes and helicopters			
Little Joe series (9 flights)	October 4, 1959, to April 28, 1961	Suborbital	10 to 169	3 to 4	3 helicopters (typical) (plus 2 airplanes on LJ II)	Visual and electronic	Ship *or* helicopter	Little Joe and Beach Abort-Development flights made from Wallops Island. Retrieval by helicopter or ship was accomplished on all successful flights and qualified the recovery methods.
Big Joe I	September 9, 1959	Suborbital	1,300	13	7 airplanes 3 helicopters	Reentry glow, SOFAR, electronic	Ship	Planned for 1,831 nautical miles but resulted in an undershoot with landing at 1,300 nautical miles—about halfway between two destroyers. No tracking information is available; but on the basis of visual sightings of reentry by three destroyers and confirmation of the landing point by a SOFAR bomb fix (T+2 hr), search aircraft located the spacecraft after acquiring beacon contact (T+3 hr) and directed a destroyer in for the retrieval operation (T+8 hr).

Table 16-I.—Summary of Recovery Operations for Project Mercury—Continued

Flight	Launch date	Description	Range, nautical miles	Recovery forces [a]		Location method	Retrieval by	Remarks
				Ships	Airplanes and helicopters			
MA-1	July 29, 1960	Suborbital (unmanned)	4.85	8	5 airplanes 3 helicopters	Visual and electronic	Salvage ship	Flight-vehicle structural failure shortly after launch. Salvage operations recovered most of spacecraft components.
MR-1	November 21, 1960	Suborbital (unmanned)	0	8	6 airplanes 3 helicopters	Visual		Launch-vehicle shut down immediately after lift-off. No recovery required.
MR-1A	December 19, 1960	Suborbital (unmanned)	204	8	4 airplanes 4 helicopters	Visual	Helicopter	Recovered by helicopter which was operating from landing ship, dock.
MR-2	January 3, 1961	Suborbital (chimpanzee)	363	8	6 airplanes 5 helicopters	Electronic	Helicopter	Retrieved by helicopter which was operating from a landing ship, dock, although a destroyer was on the scene. A contingency recovery operation (overshoot) with damaged spacecraft near sinking at time of retrieval.
MA-2	February 21, 1961	Suborbital (unmanned)	1, 244	8	14 airplanes 5 helicopters	Electronic	Helicopter	Successful suborbital flight. Helicopter retrieval and return to landing ship, dock.
MA-3	April 25, 1961	Orbital (unmanned)	0. 25	15	12 airplanes 7 helicopters	Visual	Helicopter	Guidance system failure, destructed by RSO resulting in spacecraft landing off-shore near Cape Canaveral. Launch-site helicopters successfully retrieved spacecraft.

MR-3	May 5, 1961	Suborbital (manned)	263	8	7 airplanes 7 helicopters	Visual	Helicopter	First manned mission. Spacecraft and astronaut retrieved by carrier-based helicopter less than 11 minutes after landing.
MR-4	July 21, 1961	Suborbital (manned)	262	8	7 airplanes 7 helicopters	Visual	Helicopter	Second manned mission. Spacecraft hatch prematurely opened and astronaut escaped into water. Helicopter hooked onto spacecraft but could not retrieve it. Astronaut was recovered by another helicopter and returned to carrier.
MA-4	September 13, 1961	Orbital (unmanned)	1 orbital pass	9	34 airplanes 6 helicopters	Visual	Ship	Planned one orbital-pass mission. Retrieval by destroyer after being located by aircraft in nominal landing area.
MA-5	November 29, 1961	Orbital (chimpanzee)	2 orbital passes	18	49 airplanes 9 helicopters	Electronic	Ship	Planned three orbital-pass mission terminated in planned landing area at end of two passes. Spacecraft and occupant (chimpanzee) successfully recovered by destroyer following aircraft location.
MA-6	February 20, 1962	Orbital (manned)	3 orbital passes	24	49 airplanes 14 helicopters	Visual	Ship	First manned orbital mission. Spacecraft landing in the prime recovery area at the end of third orbital pass. Nearby destroyer retrieved the spacecraft and astronaut.

[a] These figures do not include nonoperating contingency or backup aircraft.

Table 16-I.—Summary of Recovery Operations for Project Mercury—Concluded

Flight	Launch date	Description	Range, nautical miles	Recovery forces [a]		Location method	Retrieval by	Remarks
				Ships	Airplanes and helicopters			
MA-7	May 24, 1962	Orbital (manned)	3 orbital passes	20	49 airplanes 14 helicopters	Electronic	Helicopter (astronaut) Ship (spacecraft)	Planned three orbital-pass mission terminated in a landing 250 miles downrange of the planned landing point. A contingency recovery operation included pararescue deployment approximately on hour after landing. Astronaut recovery by helicopter and spacecraft retrieval by destroyer.
MA-8	October 3, 1962	Orbital (manned)	6 orbital passes	26	69 airplanes 14 helicopters	Visual	Ship	Planned six orbital-pass mission. Landing within sight of prime recovery carrier. Spacecraft provided with auxiliary flotation collar installed by helicopter-deployed swimmer teams. Spacecraft and astronaut retrieved by carrier.
MA-9	May 15, 1963	Orbital (manned)	22 orbital passes	[b] 26	110 airplanes 14 helicopters	Visual	Ship	Planned twenty-two orbital-pass mission. Landing within sight of prime recovery carrier. Spacecraft was provided with auxiliary flotation collar installed by helicopter-deployed swimmer teams. Spacecraft and astronaut retrieved by carrier.

[a] These figures do not include nonoperating contingency or backup aircraft.
[b] This number does not include 2 ships in the Middle East.

MA–9 Recovery Operations

A brief description of the recovery plan and operations for the MA–9 mission will serve as a typical example of the Project Mercury recovery, based on the philosophy and techniques previously described.

Prior to the MA–9 launch, all recovery forces were reported to be on station and ready. After insertion of the astronaut into the spacecraft, a pad-emergency egress team was standing by to assist the astronaut in the event he had to leave the spacecraft for some emergency that did not require activation of the launch escape system. This team included medical personnel, spacecraft specialists, and fire fighters in special vehicles.

Special recovery teams were located in the launch site abort landing area to provide rapid access to the spacecraft for landings resulting from possible aborts utilizing the launch escape system during the late countdown and early phase of powered flight. Because of the variations in the type of terrain and proximity to the ocean in the launch site area, these teams utilized helicopters and amphibious vehicles. Small craft operated in the Banana River, and standing by offshore were several salvage ships. Winds at the launch site were measured and abort landing positions were computed and plotted. These plots were used to evaluate possible landing hazards prior to committing the spacecraft to a launch and to optimize the positioning of these recovery forces.

Areas A through F, the pre-orbital abort landing areas stretching across the Atlantic Ocean and shown in figure 16–4, supported all probable landings in the event an abort was initiated at any time during powered flight. Landings in Areas A and B would result from an abort at velocities up to about 24,000 feet per second, and Areas C, D, E, and F would support aborts at higher velocities where programed use of the retrorockets would provide for selection of the landing area.

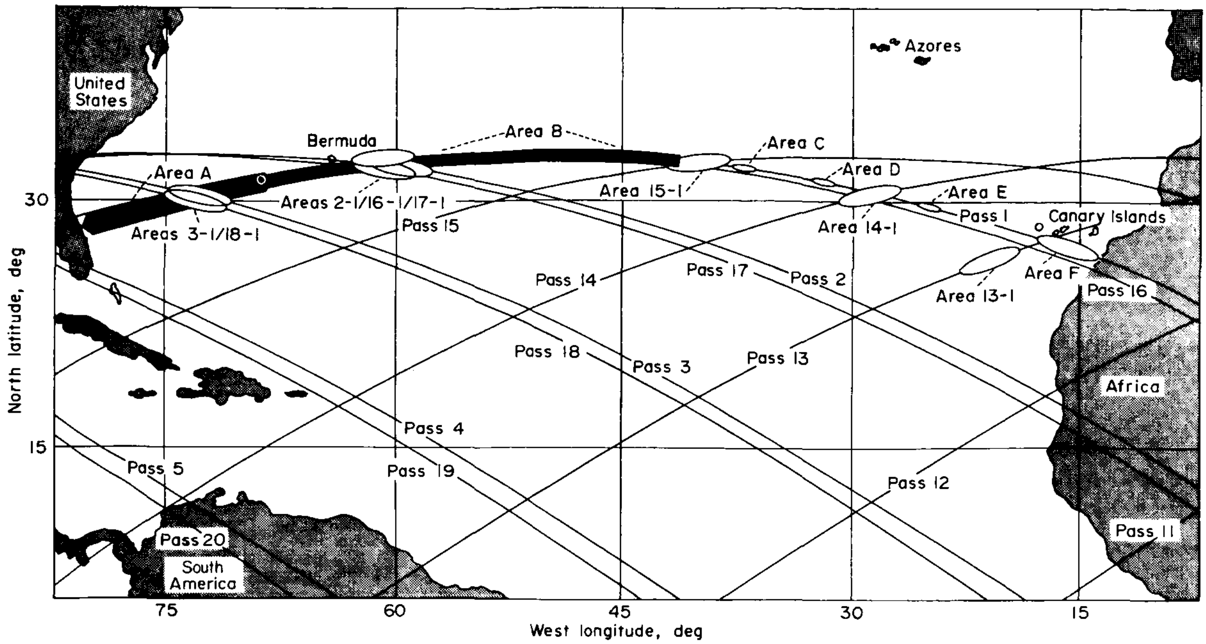
Also shown in figure 16–4 are the numbered landing areas. These locations are planned landing areas or areas in which the spacecraft could have landed if the flight had been terminated prior to the planned end of the mission. The planned landing areas were spaced so that the spacecraft would pass over one of them approximately every 100 minutes or about once per orbital pass.

Recovery forces were deployed within these landing areas so that location and assistance could be provided within a period of from 3 to 9 hours after spacecraft landing. This period, denoted as the recovery "access time," was a function of the planned deployment of recovery forces in a given area and varied according to the probability of a spacecraft landing within that area. Selection of landing areas at spacecraft ground track intersections permitted certain recovery units to move from one area to another during the flight and thereby provide support in several landing areas.

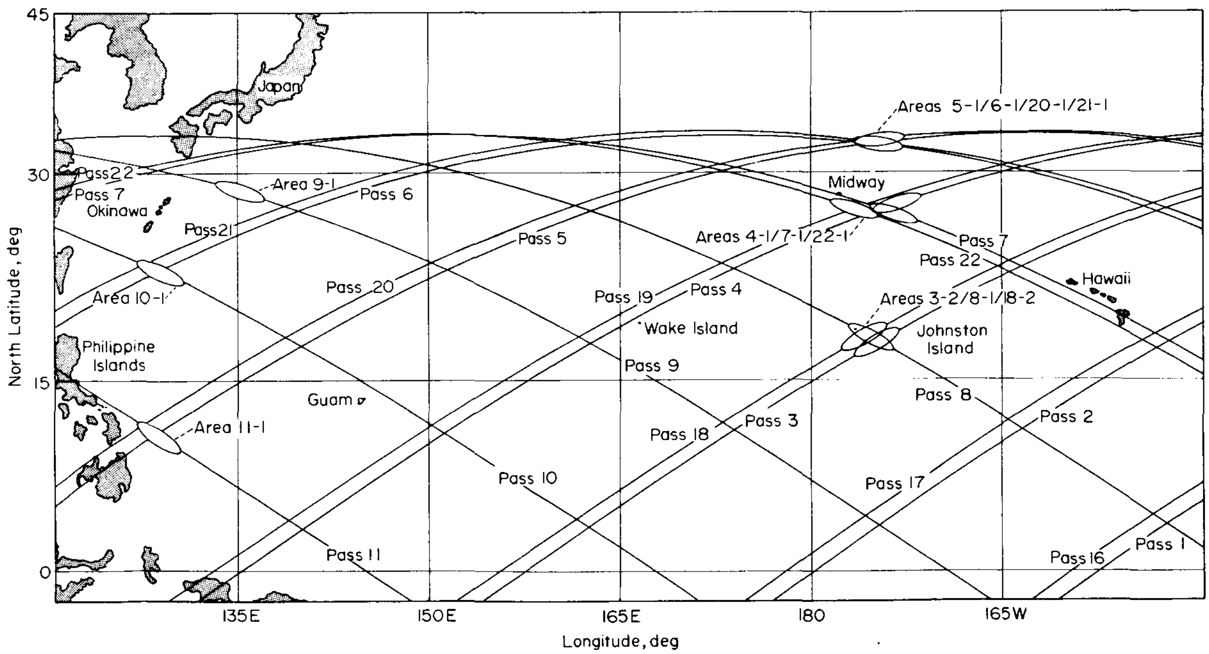
Throughout the mission, flight progress was continuously monitored, and periodically during the mission, decisions based on spacecraft and astronaut conditions were made to continue the flight. Obviously, a higher probability of landing is associated with the landing areas immediately following these decision points. Landing Areas 2–1 and 17–1 in the Atlantic and Area 7–1 in the Pacific were such areas and were referred to as "go—no-go" areas. Area 22–1, the Primary Planned Landing Area for a nominal flight, was located in the Pacific about 70 nautical miles southeast of Midway Island and adjacent to Area 7–1. Since the probabilities of landing in these two areas, 2–1/17–1 in the Atlantic and 7–1/22–1 in the Pacific, were considered to be higher than for other planned areas, recovery-support helicopters operating from aircraft carriers were provided for a more rapid access to the spacecraft and astronaut after landing.

A total of 23 ships and 44 aircraft were employed in supporting the planned water landing areas designated for the MA–9 mission, of which 12 ships and 26 aircraft were in the Atlantic planned landing areas, and 11 ships and 18 aircraft were in the Pacific planned landing areas. Additional search aircraft were available as backups to these aircraft on station.

A total of 66 contingency recovery aircraft and associated personnel were on alert status at staging bases around the world to provide support in the event a landing should occur at any place along the ground track. These aircraft were equipped to locate the spacecraft and to provide emergency on-scene assistance if required. A typical support unit at a stag-



(a) Atlantic Ocean



(b) Pacific Ocean

FIGURE 16-4.—MA-9 planned landing areas.

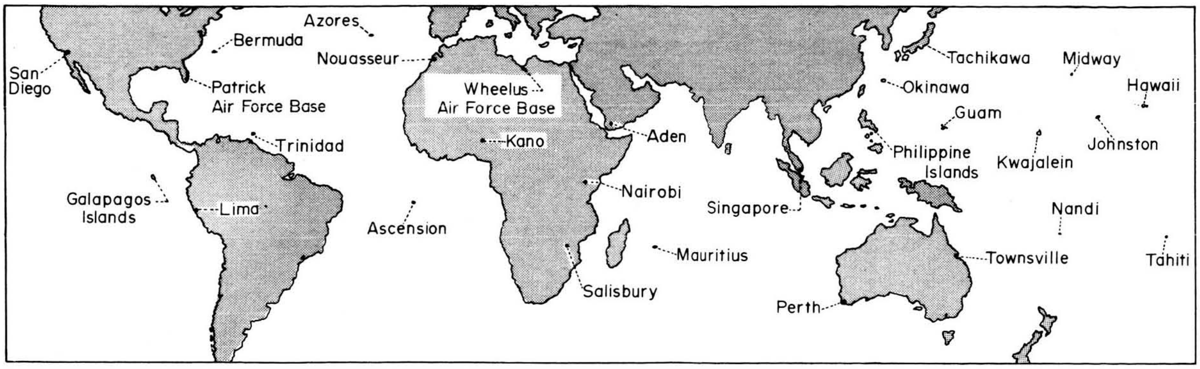


FIGURE 16–5.—MA–9 staging locations for contingency recovery.

ing base consisted of 2 or 3 long-range aircraft with pararescue personnel. The location of contingency recovery units for the MA–9 mission is shown in figure 16–5. All recovery forces, including those in the planned landing area and those supporting contingency landings, were linked by communications with the Recovery Control Center located within the Mercury Control Center at Cape Canaveral.

The location and retrieval of Astronaut Cooper and his spacecraft were straight forward. The spacecraft of the MA–9 mission landed approximately 4½ miles from the recovery aircraft carrier, the *USS Kearsarge*, positioned in the center of Area 22–1. The *USS Kearsarge* had radar contact with the decending spacecraft, and carrier personnel visually sighted the spacecraft as it descended on its main parachute.

Helicopters launched from the carrier prior to spacecraft landing were in excellent position to deploy swimmers who immediately installed the auxiliary flotation collar around the spacecraft. As the carrier approached the spacecraft a motor whaleboat carried a retrieving line to the spacecraft (fig. 16–6). The spacecraft was lifted clear of the water and placed on the carrier deck. The explosive-actuated hatch was then released, and medical personnel began their initial examination of the astronaut.

Following a debriefing and rest period aboard the carrier, the astronaut and his spacecraft were airlifted to Cape Canaveral from Honolulu, Hawaii.

FIGURE 16–6.—Motor whale boat carrying retrieving line to MA–9 spacecraft.